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Simarouba Oil Methyl Ester Production using NaOH Catalyst and Investigation and Comparison its Properties with Diesel and Kerosene Fuels.

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Abstract – *Searching for renewable energy sources gains considerable scope in the present situation due to the scarcity and environmental disadvantageous of highly depended petroleum based fuels. Biodiesel is kind of renewable energy source which is used in CI engines with diesel and other petroleum based fuel blends instead of using direct diesel. Biodiesels are directly derived from the feedstock of edible or non-edible vegetable oils and animal fats carrying transesterification. Here the production of simarouba biodiesel or simarouba oil methyl ester from the low FFA value, non-edible simarouba crude oil transesterification in the presence of NaOH catalyst and methanol is carried and evaluated its properties. The obtained simarouba oil methyl ester (SOME) properties are in ASTM standard values and its few important properties are made comparison with the petroleum based fuels diesel and kerosene. By this comparison get density, viscosity and flash points of the SOME are greater than the diesel and kerosene. And calorific value is less the both the petroleum base fuels.*

Key Words: *Biodiesel, Transesterification, FFA Value, Simarouba, SOME, Vegetable Oils and Animal Fats.*

1. INTRODUCTION

In the present era any countries development, civilization and strengths are recognized based on the energy source they are using and rate of consumption of energy. In the world almost 90% of countries depends on the fossil fuels, these are main energy source in the every sector like transportation, industries and home uses also, the problem is that fossil fuel are non-renewable energy sources and according to studies they will exhausted in future [1]' So it is necessary to find out the alternate energy sources for future before the depletion of fossil fuel energy sources. The best alternative energy sources for fossil fuels are renewable energy sources because the sources are recycled by the nature itself, non-exhausted and environmentally friendly sources. The renewable energy sources includes solar energy, wind energy, hydro energy, wave energy, geothermal energy, some biochemical energy sources and biofuels.

Biofuels are the fuel they are derived from the naturally available raw materials such as plants parts and animals' wastes. Biodiesels are the kind of biofuels they used as alternative fuel to petroleum based diesel in diesel engines. Because of its renewability biodiesel gains good scope in transportation field. Biodiesels are derived from the vegetable oils both edible and non-edible oils and waste animal fats these are called as feedstock for biodiesel[2] In that non-edible oils considered as better feedstock compared to edible oils and waste animal fats because in future arises shortage of edible oil for daily food and killing of animals for the biodiesel production. And non-edible feed stock also reduces production cost of the biodiesel compared to other feed stocks.

There are different kinds of non-edible vegetable oils are available for biodiesel production in those simarouba seed oil is kind of non-edible feed stock. It is used for edible purpose in some countries after carrying some refining process but its utilization in non-edible purpose high that is why it is generally considered as non-edible oil. Simarouba oil has better properties and less FFA value compared to other non-edible oils [3]. So purpose this paper is to understand production of biodiesel from the simarouba crude oil in laboratory using basic equipment, knowing its properties and comparison of its properties with diesel and kerosene fuels.

2. SIMAROUBA BIODIESEL (SOME) PRODUCCTION

The simarouba oil methyl ester extraction from simarouba crude oil takes two stage transesterification process. The crude oil has nearly FFA 2% it is enough for production of biodiesel using single stage transesterification but we getting less yield compare to the two stage process of the oil [4]. Because FFA content forms the waste products at the time of transesterification. So it better to kept it is less than 1% this can be done by first stage esterification called acid esterification here only pretreatment of oil taking place. In second stage transesterification of is carried using base catalyst to get fatty ester or biodiesel [5]. Method and materials required for two stage esterification of SOME production explained below.

Equipment used: Three neck round bottom flask (capacity of 100ml, 500ml, 1000ml or 2000ml), magnetic stirrer, Electrical heating mantel, separating funnel (capacity of 500ml and 2000ml), thermometer, glass condenser, 250ml capacity burate conical flask, beakers, measuring jars and other accessories.

Chemicals used: Sulphuric acid (H_2SO_4) as an acid catalyst, NaOH as base catalyst, methanol, distilled and water

2.1. Acid esterification:

1000 ml of crude oil added to the three neck round bottom flask having capacity of 2000 ml and heated up to 55 ^{0}C and kept on the magnetic stirrer with constant stirring then added the mixed solution of 10 ml sulphuric acid and 200 ml of methanol into the oil flask [6] [7]. Then maintained temperature 55 ^{o}C to 60 ^{o}C with constant stirring for 60 minutes. After the reaction solution is poured into a separating funnel and kept the solution for settling about 8 hour. After that separate the bottom portion of residues, middle portion of oil and top portion of methanol as shown in Fig 1.

2.2. Alkaline Transesterification

1000ml of crude oil is taken in 2000ml capacity of three neck round bottom flask and heated up to 45^{0}C then poured a pre-prepared methanol NaOH catalyst solution (6gm of catalyst and 180ml of methanol) into the flask with constant stirring on magnetic stirrer and kept reaction for 45 minutes [8]. Then poured the solution into a separating funnel as show in Fig 2 to separate the glycerol and catalyst content from the simarouba biofuel Then carried out water wash of biofuel after that heat the water washed biodiesel above 100^{0}C for removing water content and other residuals

a)Acid esterification b) Alkaline transesterification.

Fig-1. Two stage esterification of SOME production

a) Three layered reaction solution in separating funnel.

b) Soap water and SOME layers at water wash time.

c) Final stage of water wash removed all soap content.

d) Heating of SOME up to 100^{0}C after water wash.

Fig.-2. Separation of simarouba biodiesel from the transesterified reaction solution.

3. INVESTIGATED PROPERTIES OF SIMAROUBA BIODIESEL

After the production of simarouba biofuel it is necessary to investigate its properties and the obtained properties must be within the prescribed range of ASTM standards.

Table -1. Investigated SOME properties.

Properties of fuel and units	SOME	ASTM Standard values
Density(kg/m^3)	864	870 to 900
Specific Gravity	0.864	0.87 to .90
Viscosity(cSt)	4.06	1.9 to 6.0
Flashpoint (^{o}C)	188	130 minimum
Fire point (^{o}C)	202	----
Cloud point (^{o}C)	18	-----
Pour point (^{o}C)	13	-----
Calorific Value(MJ/kg)	40.215	------

Investigated SOME properties are tabulated in table 1.The obtained SOME properties satisfies the ATSM Standards hence it is acceptable for use.

4. FUELS PROPERTY COMPARISION.

The basic important properties fuels are density, viscosity, flash point and calorific value. So in this study comparison of these properties of SOME, diesel and kerosene is carried and properties values are tabulated in table 2.

Table -2. Properties of SOME, diesel and kerosene fuels.

Properties of Fuel and Units	SOME	Diesel	Kerosene
Density(kg/m^3)	864	840	808
Viscosity(cSt)	4.06	3.24	1.64
Flashpoint (^oC)	188	55	60
Calorific Value(MJ/kg)	40.215	42.5	43.054

4.1. Density comparison

Density of SOME, Diesel and kerosene are represented in chart-1, from this chart we can easily understand that density of biofuel is 864 kg/m^3 which is greater than the diesel and kerosene. But kerosene has less density than the diesel. This shows that simarouba biodiesel has greater molecular affinity and higher molecular concentration than the diesel and kerosene in the unit volume. That's why it is less transparent and higher adhesive compare to the diesel and kerosene.

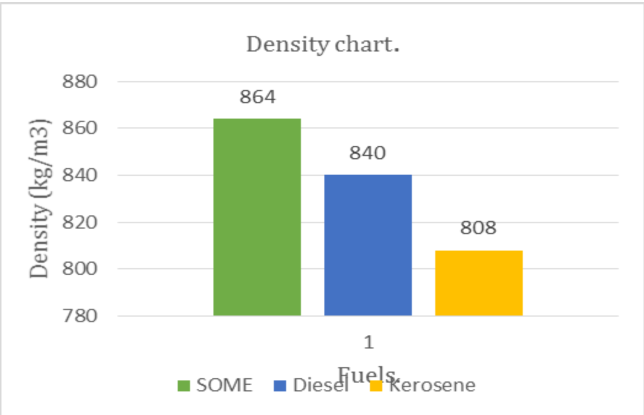

Chart-1. Variation of density in different fuel.

4.2. Viscosity Comparison.

The kinematic viscosity of the fluid investigated using Redwood viscometer and the obtained kinematic viscosity values for fuels represented in chart-2 in centistokes (cSt). From the chart we can understand that kinematic viscosity of the simarouba biofuel is 4.06cSt which is greater than the diesel and kerosene. This results that thickness and adhesiveness of simarouba biodiesel is greater than that of diesel and kerosene. In these fuels kerosene has viscosity of 1.64cSt which is very less compared to both simarouba biodiesel and diesel fuels. Hence it has less adhesive property. The kinetic viscosity of simarouba is slightly greater than diesel so it is not much affected on diesel engine performance.

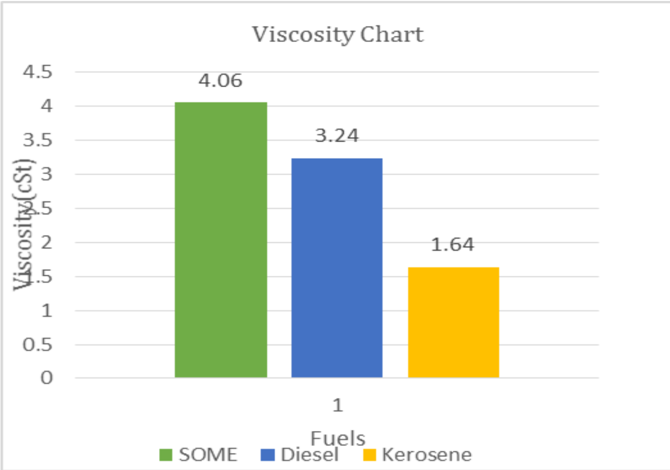

Chart-2. Variation in viscosity of the fuels

4.3. Flash Point Comparison

Flash point of the each fuels is investigated using Pensky – Marten's closed cup apparatus and the values are represented in chart-3 in ^oC. Flash point of the simarouba biofuel is 188^{0}C which is very much greater compare to the kerosene and diesel. Here we obtained flash point of the kerosene is slightly lesser than the diesel. The flashpoint depends on the volatility of fuel therefore kerosene has greater volatile than the diesel, so it has less flash point than the diesel. But simarouba biodiesel comparatively very less volatile that's why it has very high flash point. Hence perform the diesel engine few modification are required i.e. high compression ratio is required for better atomization to reach auto ignition temperature for combustion

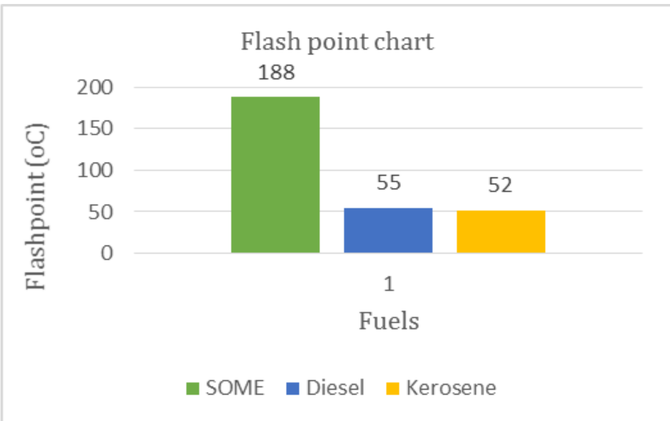

Chart-3. Variation in Flash point of the fuels

4.4. Calorific value Comparison

Calorific value of the fuels are investigated using bomb calorimeter. Obtained calorific value of each fuel is represented in chart-4. From the chart we can understand that calorific value of the simarouba biofuel is 40.215MJ/kg which is lesser than the both diesel and kerosene. Here obtained calorific value for kerosene is 43.054MJ/kg which is greater than the diesel. The calorific value of the fuels depends on their chemical composition. Highly influenced components are hydrogen and carbon.

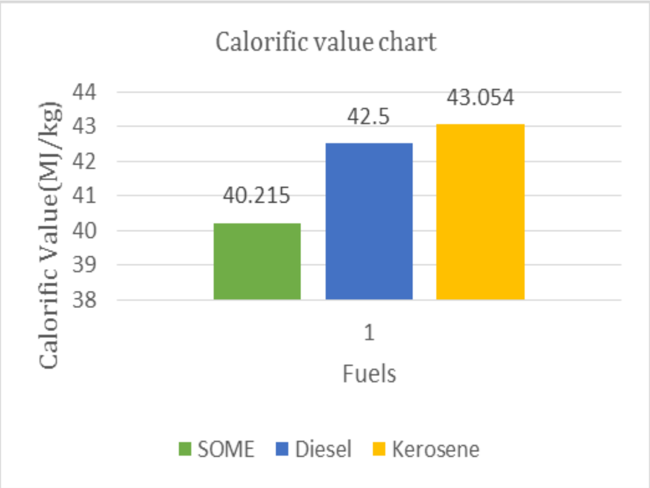

Chart-4. Variation in Calorific Value of the fuels

5. CONCLUSION

Simarouba oil is non-edible and having less FFA value therefore it is suitable feedstock for biodiesel production. By carrying two stage transesterification to the simarouba oil we can get better yield. The obtained biodiesel having properties in the range of ASTM standards. Density, viscosity and flash point of the simarouba biodiesel are greater than the diesel and kerosene value. Calorific value of the kerosene is greater than the diesel and diesel calorific value is greater than the simarouba biofuel. Hence it concluded that the simarouba biodiesel which is used as a fuel to perform the existing diesel engine with high compression ratio.

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